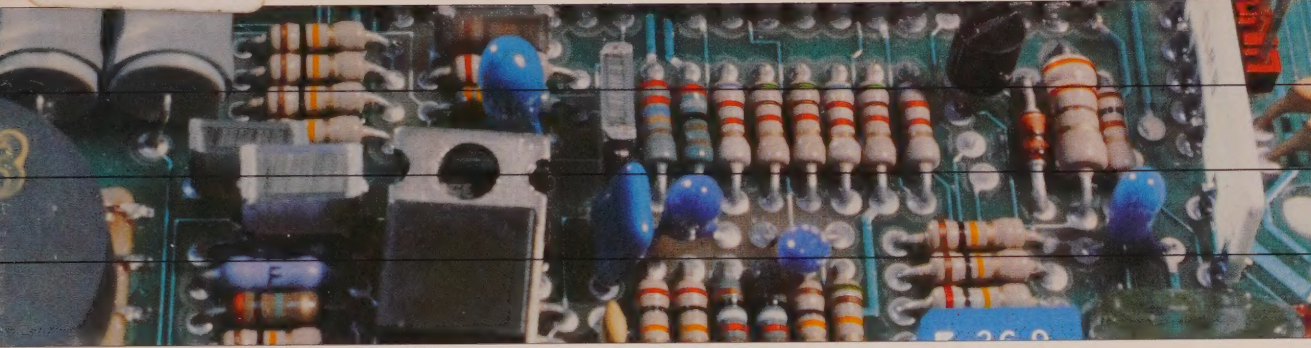


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MICROELECTRONICS

Report of the Task Force to the Government of Ontario

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The Honourable Larry Grossman
Minister of Industry and Tourism
Government of Ontario
Queen's Park
TORONTO, Ontario

October 9, 1981

Dear Mr. Minister:

I am pleased to forward to you herewith the report of the Task Force on Microelectronics.

The Task Force recognizes that this report is not a complete response to the charge you gave us last year. We find, however, that the urgency you expressed when giving the charge was very well founded and have, therefore, concluded that it is better to put in a report covering a series of recommendations relating to the industrial sector and to add to those a further recommendation that you complete the charge through establishing a second task force. We say a second task force as we believe that a different set of experiences is necessary to properly address the areas of applications with their socially significant impact; such issues as the accuracy, accessibility and privacy of personal information stored in computer-based systems and the opportunities and challenges emerging with the office of the future. Our studies did confirm our views that the impact in the office and home will be significant and require the same awareness and planning.

We should point out that this Task Force chose to operate in a somewhat different mode than is perhaps traditional. We based this on your perception of urgency. We selected the members of the Task Force for their wide experience in the industrial and educational sections and, based on that experience, enlisted the aid of a great number of the staff of your ministry and, through them, of other ministries. It is on the work of these individuals that we base our recommendations. In passing, I would like to express the Task Force's appreciation for the extremely good co-operation we received. It was a satisfying way to operate and a relatively expeditious one.

We would see the recommendation to act promptly in establishing a Centre for Micro-electronics as being our prime recommendation. This is based on the belief that evolving the current infrastructure of small business is the best way to invest resources and is the more urgent because of the microelectronic revolution.

The other major recommendations relate to the three areas of: transition planning and skill retraining, the supply of highly trained people and the support of the few major establishments in the Canadian scene to become world class.

The Task Force stands ready to discuss these recommendations and rationale with the Ministry.

It has been a satisfying experience to support your initiative.

Yours sincerely,



D. A. Chisholm
Chairman
Microelectronics Task Force

Introduction

The Task Force on Microelectronics was announced by the government of Ontario in March, 1980. Reporting to the Honourable Larry Grossman, Ontario Minister of Industry and Tourism, the Task Force was directed to investigate and report on:

- the need for policies and programs that will enable Ontario to exploit fully the industrial benefits produced by microelectronics technology;
- the actual and potential social impact of microelectronics technology.

The Task Force first developed and adopted a statement of purpose that covers all aspects of its mandate. It is:

"to develop policies and programs that contribute to the economies of Canada and Ontario by:

- creating an environment that encourages a strong microelectronics industry in Ontario;
- ensuring that microelectronics technology is put to effective, profitable use throughout the entire economy of Ontario;
- encouraging an adequate supply of people in Ontario who are trained in the industrial applications of microelectronics technology;
- ensuring that the above are achieved with every possible consideration of the impact of microelectronics on the people of Ontario."

The Task Force Structure and Approach

In establishing the Task Force, the Ontario government indicated that it believed there was an element of urgency in developing plans for managing the change that microelectronics will bring. The charge to the Task Force, therefore, included a request that the government be given interim reports and, should the need for urgency be supported, a report by the fall of 1981. Given this schedule the Task Force felt it necessary to adopt a somewhat different approach to its work than the route of public hearings.

The Task Force was formed with the intent of involving authorities from industry, education and labor. In addition to these three areas a conscious effort was made to involve experts from large and small high-technology companies in Ontario and from the multinational sector.

The Task Force comprised eight people:

Donald A. Chisholm,
President,
Innovation and
Development,
Northern Telecom Limited

G. Pattinson,
President,
Canadian District,
International Union of
Electrical,
Radio and Machine Workers

R.J. Butler,
Secretary,
Management Board of
Cabinet,
Ontario Government

M.C.J. Cowpland,
President,
Mitel Corporation

D. Cunningham,
Chairman,
Gandalf Group

T.H. Savage,
President,
ITT Canada Ltd.

I.P. Sharp,
President,
I.P. Sharp Associates

K.C. Smith,
Chairman,
Department of Electrical
Engineering,
University of Toronto

The members of the Task Force worked with the staff of the Ministry of Industry and Tourism to have access to the literature relating to microelectronics and its impact. This literature is extensive and to a large part current. Nearly every major government and technologically oriented organization has examined the impact and proposed actions of either exploiting or managing the technology of silicon integrated circuits. One of the most quoted studies is the report to the President of France entitled *The Computerization of Society* by S. Nora and A. Minc. The literature reviewed by the Task Force is in general agreement with the comments that V. Giscard d'Estaing made about that report:

"The applications of the computer have developed to such an extent that the economic and social organization of our society and our way of life may well be transformed as a result. Our society should, therefore, be in a position both to foster this development and to control it so that it can be made to serve the cause of democracy and human growth."

The literature is also reasonably agreed that, without planning, the impact of microelectronics will be a revolution, but that, with planning, it can be managed to society's good. From the literature and its own experience the Task Force found itself in firm agreement that the impact on small business and the employees of such companies was well founded. The Task Force, therefore, chose to carry out its study in a progressive way. It began by examining the small businesses directly affected by the integrated circuit and worked toward the second level of impact, those organizations affected by the application of microelectronics-based products.

Equally on the technological axis the Task Force chose to work from chips to circuits to products to systems. In this way we believed that useful input could be made on the most urgent areas while providing directions for further initiatives in the other areas.

From this point, the Task Force drew on its own extensive experience to create for itself a number of hypotheses about the sectors and phases involved. Then, through the staff of the Ministry of Industry and Tourism, it drew on the skills and experience of

the staffs of other ministries to test these hypotheses against their data bases and to carry out a number of specific studies (Appendix, page 10). The co-operation and support the Task Force received was most gratifying. From the tested hypotheses the Task Force developed the conclusions and recommendations in this report. Throughout the period the Task Force made its thinking available to the Ministry of Industry and Tourism. Specifically, the Task Force assisted the ministry in defining the role, function and scope of the proposed Microelectronics Technology Centre.

Given the mandate of the Task Force, this approach worked well and is recommended for consideration for future studies in which time is at a premium.

Summary of Findings

Background studies conducted for the Task Force confirm the all-pervasive influence that advances in microelectronics will have on society. The technology has brought the pocket calculator and digital wrist watch within reach of the average consumer; it promises, in the foreseeable future, to make the computer a household entity, if not directly then indirectly, in such forms as microprocessor-controlled appliances, alarms and controls.

The basic driving force behind these advances has been, and will continue to be, the integrated circuit. Every year the complexity of the circuits that can be crammed into a single small chip of silicon is very nearly doubled. Yet the cost of these more complex chips is hardly more than that of chips produced a year or even several years earlier. The integrated circuit is a powerful element in the fight against inflation. The Task Force believes that these benefits will continue to expand microelectronics technologies for many years to come.

Changes this fundamental are difficult to predict and will differ depending on the society the technology is a part of, but it is clear that microelectronics is one of the critical technologies behind the "post-industrialization" of Western society. Its impact is changing our lives as consumers and workers, as well as the manner in which we communicate among ourselves. Whole new industries have been and will be created, leading to an information-based element in economy.

Some degree of sovereignty in microelectronics technology is regarded as *essential* for long-term economic growth. Canada, as a small industrial power in an increasingly interdependent world, must not isolate itself from the mainstream of this strategic technology. We can simply buy the microelectronic-based products and systems being developed, or we can selectively develop our own expertise. We can stand by while other countries use the technology to automate their industries, eroding our ability to compete in world markets, or we can use the technology to enhance our competitiveness, protect and create jobs, improve the quality of our work and

home environments and raise our standard of living. The resource needed is primarily well-trained and motivated people, a renewable, even expanding resource.

A rational, effective effort at developing and using microelectronic-based technology in the development of products, processes and systems can lead to the creation of "me-first" Canadian products that are innovative and truly competitive internationally rather than "me-too".

Canadian industry has substantial strengths in special areas of electronic products and systems. In this industry, Canada has developed world-class capability. The potential to build on this base in the coming decades is enormous. There are, however, a great many Canadian companies, particularly small firms outside the electronics industry, that will find it difficult to adapt to the continuous and rapid technological changes.

The challenge is to manage these changes. We can gain as much from carefully attending to the social impact of this new technology as we can from its industrial effects. In fact, the reason for studying the social effects is that they will be one of the major factors determining how microelectronics is applied in the economic, labor and educational sectors. Our society, like our markets, is one of the most open in the world. To keep it that way, we must build on our strengths to remain competitive internationally and to maintain and extend the leadership we already have in a number of trading areas.

The Task Force is cautiously optimistic about our ability to meet the challenge. Disruption to the work force *can* and must be minimized. Displaced workers *can* be retrained and, with planning, can often be retrained before displacement. An adequate supply of skilled labor *can* be ensured. The quality of working life *can* be enhanced. Our young people *can* be given the skills needed to flourish in the age of microelectronics.

The note of caution is that the government of Ontario can act only as a catalyst in the process of change. It cannot independently ensure that the process is completed; that is up to us. The government of Ontario is one of many governments in Canada, Canada, just as Canada itself is only one entity in a highly competitive world.

It is the view of the Task Force that all sectors and members of society must participate in the process of change, to manage change within the current social infrastructure and to build on the infrastructure wherever possible. We must move quickly:

- to grasp the industrial and societal opportunities presented by the rapid development of micro-electronic technology;
- to accelerate the diffusion of the technology throughout Canadian society, thereby strengthening our competitive capability.

The findings of the Task Force recognize:

- that a wide awareness of the potential of micro-electronics and microelectronic-based products is vital to the co-operative management of change;

- that small firms have a special need to be aware of changing technology and must have help in acquiring it, introducing it and using it;
- that establishing competitive capability in micro-electronics and accelerating its diffusion depends to a large extent on the concurrent development of components, hardware and software;
- that software is an industry in its own right with substantial growth potential.

The introduction of this technology will change job-skill requirements. The impact on occupational groups will be uneven. In some sectors of the economy, the introduction will slow the rate of job growth, at least in the short term. Overall, micro-electronics can, with planning and investment, create jobs. This is especially true if the technology is used to build on economic strengths. There is no doubt that technological change leads to job displacement and the obsolescence of hard-won skills. The challenge is to ensure that the technology does not simply eliminate jobs in Canada and create new jobs elsewhere. Without awareness, followed by planning and co-operation, the results could be disastrous.

To manage the changes that will characterize the widespread introduction of microelectronic technology, and to maximize its social and economic benefits, the following major issues must be addressed:

- the availability of a sufficient supply of skilled personnel;
- the potential impact on the labor force;
- the potential for improving the quality of working life;
- the opportunities to use microelectronics to make continuing education a reality for all citizens;
- the opportunities for the physically disabled in terms of the design and development of technical aids and access to education and employment;
- the inadequate level of awareness and understanding of microelectronics;
- the gap between the information-rich and the information-poor;
- the need to establish an economic environment that fosters the industrial use of microelectronics.

Government, labor, industry, education and the media have a role to play in addressing these issues.

Action to Date

The Ontario government has announced a number of initiatives designed to support the development and diffusion of microelectronics technology. They include:

- establishing a Microelectronics Technology Centre;
- establishing centres based on computer-assisted design, manufacturing and robotics technology;
- establishing pilot-project funding for the introduction of new-process technology;
- providing \$5 million to support a Telidon-based tourist information system;

- assisting in the development of a Canadian-produced educational microcomputer, with associated software.

The Task Force supports these initiatives and, in particular, recommends the early establishment of a Microelectronics Technology Centre. Such a centre, closely associated with computer-assisted design, manufacturing and robotics technology, represents an important mechanism to diffuse these technologies throughout Ontario industry.

Recommendations

Industrial Development

Objective: To exploit fully the industrial benefits produced by microelectronic technology.

Recommendation 1: That the government of Ontario ensure that its proposed Microelectronics Technology Centre provide expertise in the application of integrated circuits and related tools and software, particularly to small- and medium-sized Canadian firms.

In particular, that the centre:

- develop a base of up-to-date information and expertise available from Canadian and world-wide sources and act as an interface for companies wishing to utilize that expertise;
- assist in maximizing the diffusion and use of micro-electronics technology, particularly among firms not now familiar with the technology or its impact;
- provide design, development and test services to assist firms in developing the skills needed to utilize microelectronic technology;
- establish and maintain a list of sources of components and facilities, which could be available to firms that use the centre's design, development and testing facilities;
- act as a training ground for engineers, technicians and technologists;
- build a body of expertise and experience in managing the transition to microelectronics technology within firms;
- build a body of expertise on new-job design that improves the quality of working life and of expertise on the resources in other organizations that can aid such design.

Rationale: Small- and medium-sized companies generally do not have the human or financial resources to undertake leading-edge research and development. Yet to become and remain competitive internationally, firms must offer unique products.

The use of microelectronics technology in the development of new products and in the manufacturing process is essential to the success of Canadian manufacturers. It offers opportunities for product

innovation and improvements in product quality. It can lead to improvements in productivity both in manufacturing processes and in the service sector.

For larger firms that could benefit by moving toward custom chip design but either have no experience or whose requirements do not represent a project of commercial interest to most silicon chip-producing houses, the centre can assist in source development and in spreading some of the costs inherent in the design and testing stages of component development.

Recommendation 2: That the government of Ontario review its own programs and work with the federal government to improve the climate for research and development, export marketing and global product mandating. That particular consideration be given to:

- expanding the definition of R&D that qualifies for federal and provincial support and for tax incentives to include marketing and pre-production costs;
- designing programs and procedures so as to recognize that new companies may not have the revenue base to take advantage of existing incentive programs;
- designing R&D incentive policies that recognize the importance of export marketing;
- providing tax incentives in the province of Ontario that parallel federal tax treatment of R&D expenditures;
- working with the federal government and its agencies to support the export efforts of individual companies, particularly where the authority of government can greatly aid selling activity;
- selectively assisting firms through a preferential procurement policy, with a view toward developing long-term international competitiveness;
- providing assistance to firms that wish to carry out, or contract for, specialized professional surveys of export markets;
- providing assistance to firms in their attempts to take advantage of federal programs and procedures designed to offer export assistance.

Rationale: Successful Canadian firms invest heavily in research and development. They recognize that Canada's markets alone are not large enough to generate the revenue needed to support the R&D programs they must have.

With respect to foreign-owned multinationals operating in Canada, their behavior is important to our future growth prospects. Global product mandating can substantially improve their contribution to the Canadian economy. The rationale for such mandates must, however, be sold within the overall corporate structure. The ability of the Canadian subsidiary to sell the idea depends on whether the corporation sees a clear advantage in giving a mandate to its Canadian subsidiary. A key element in this perception is the kind of government support programs and incentives available in Canada.

Expanding the programs and incentives that encourage innovation in Canada—in relation to both R&D and exports—would help Canadian firms increase their investment in R&D. It would also help the Canadian subsidiaries of multinationals obtain global product mandates from their parents.

Selective assistance through procurement can help young companies get off the ground. It provides a base for expansion into new markets and serves as a “seal of approval” that the firms can market as an endorsement in international markets.

However, since exports are essential if Ontario is to build more world-scale, high-technology industries, the provincial government will have to be alert to any actions or programs that might trigger protectionist measures by our trading partners.

Recommendation 3: That the proposed Microelectronics Technology Centre, in co-operation with industry, monitor the ability of Canadian industry to secure adequate supplies of integrated circuits, and that the centre advise the government with respect to support required by Canadian manufacturers to meet these needs.

Rationale: The Canadian market for integrated circuits (ICs) is large. However, it is extremely fragmented. The demand is for literally hundreds of different types of components, none in large volume by industry standards of components. As a consequence, IC manufacturers cannot justify the investment they would have to make in Canada to get into the general market. It cannot be assumed at this time that a new Canadian general silicon house could export the bulk of its manufacture since currently world supply exceeds demand.

As a result, Canada imports most of the ICs it needs. Most ICs produced in Canada are used by the firms that produce them. Small Canadian firms find it difficult to establish a source of supply for ICs, primarily because they do not use large numbers. This is particularly true of new firms or firms in transition.

The centre can help these firms by providing them with expertise and by helping them establish sources of secure supply.

Using the Microelectronics Technology Centre to absorb the cost of design, development and testing is a way to address the problem at this time. However, the potential for eventually expanding IC-production capability should continue to be monitored.

Recommendation 4: That the government of Ontario work with the federal government to stimulate investment in high-technology ventures. A priority in this regard would be the design of new tax incentives to complement provincial SBDC legislation.

Rationale: Advice and funds from the venture capital market can strongly stimulate the development of the high-technology industry in Canada. They can also accelerate the rate at which microelectronics technology is spread throughout the Canadian

economy. Tax shelters like those available to the film industry could be made available to high-tech companies. This step alone would greatly enhance the investor appeal of the high-technology industry in Canada.

Recommendation 5: That the costs of purchasing foreign technology through license be considered as eligible for federal and provincial support programs on a selective basis. In addition, that the restrictive effects on technology exports of provisions in existing support programs respecting licensing of Canadian technology abroad be reviewed.

Rationale: Licensing of technology from foreign interests is often perceived as inhibiting the development of Canadian R&D capabilities and as inhibiting our international competitiveness. As a consequence, the importance of licensed technology to Canada's technological advancement is often overlooked.

Technology imported to accelerate or supplement existing capabilities and to serve as a springboard for further development, can create jobs at home and strengthen our competitive position abroad. Licensing is often a vital first step toward well-managed change. Japan is a case in point.

Similarly, licensing Canadian technology abroad can open otherwise closed markets to Canadian firms, thereby generating fees, royalties and jobs for Canada.

Recommendation 6: That governments recognize the importance of software development to the diffusion of microelectronics technology, and the emergence of software as an industry in its own right. In particular, that consideration be given to:

- treating the design or programming of software as R&D and also treating the supply of software packages as business eligible for exemption from provincial and federal sales tax, the same as in the hardware manufacturing business;
- allowing manufacturing investment tax credits and accelerated depreciation allowances to be applied to the software and computer-service industries;
- making allowance for prorating use of equipment for software R&D and making such portion eligible for R&D incentives.

Rationale: Software is the means for communicating with hardware. It is the set of rules that controls machines. Rapid development of semiconductor technology in the 1970s, especially the development of programmable integrated circuits, has increased the requirement for software.

The ability to produce software and the cost of software will have a significant influence on the growth of the electronics industry and on the rate at which microelectronics technology is acquired and used by other industries.

Software has, in fact, emerged as an industry in its own right. Hardware is the means of production. The product is intellectual content. A software-

production operation can be located anywhere. The industry is growing rapidly and offers very good job-creation prospects.

A reduction in the cost of burden on software production would encourage investment and could establish Canada as a major location for software suppliers.

Recommendation 7: That a rebate be provided to Ontario computer-service companies for the sales tax they pay for equipment they lease to customers outside the province, and that Ontario abolish the sales tax on leased communications lines used to support computer services.

Rationale: Other jurisdictions charge sales tax on computer services billed to the user. The tax is applied regardless of where the service comes from. This approach should be considered in Ontario because the present tax-duty regime in Ontario discourages Canadian suppliers and favors foreign suppliers. Such a tax would also offset some of the revenue loss from tax concessions recommended to encourage software development.

The Ontario sales tax on leased communications lines terminating outside the province is paid only when the leases are in Ontario. Leases with telephone companies outside Ontario are not subject to this tax. This results in less revenue for the Ontario common carrier.

Impact on the Labor Force

Objective: To maximize the opportunities microelectronic technology offers for improving the quality of working life and to assist in managing the transition and easing the adjustment to microelectronics in the workplace.

Recommendation 8: That government, industry and labor develop a co-operative program to:

- make maximum use of government programs aimed at training and retraining workers and at helping them adjust to changes in the workplace;
- monitor the impact of microelectronic technology on the health and safety of workers and users;
- support research into such issues as ergonomics, radiation dangers, stress and other questions related to new-job design, and publish the results of such research;
- recommend the timely development and enforcement of health and safety standards where necessary;
- emphasize and provide advice to industry on the development of effective in-house training programs. Consideration should be given to methods of financially supporting experimental programs in selected areas where initiatives are being taken;

- ensure that adequate income-support programs are in place to ease the adjustment of displaced workers.

Rationale: The development and diffusion of microelectronics technology is essential to the future competitiveness of Canadian industry and, therefore, job maintenance and creation.

It is in the interest of workers, employers and government that technological changes be introduced in a smooth, nondisruptive manner and with a minimum of adverse effects. Such graceful transitions will require careful planning and awareness and co-operation of all groups.

The introduction of microelectronics in product design and of microelectronic products in the workplace will, in the short term, make skills obsolete and eliminate or displace some jobs. Suitable transition plans must be in place. Organizations in transition, business and labor will need advice on planning and assistance in retraining. In the longer term, if we in Ontario can gain leadership positions in some high-technology areas, the net impact on employment should be positive.

Special attention will be required to the needs of female workers, many of whom are now employed in low-skilled jobs that will be among the first eliminated as a result of technological change.

With respect to the working environment and job content, microelectronics offers substantial opportunities for improvement. Proper management of its introduction can minimize the inevitable stress that can be created by new technology while improving the overall quality of the work environment.

For example, tedious or hazardous work can be eliminated; the ability of workers to perform tasks can be improved through the immediate access to information that the new technology can provide. However, thoughtless design of jobs and equipment can just as easily lead to a deterioration in working life; new equipment can become a source of stress rather than a release from it.

Manpower Availability

Objective: To secure an adequate supply of appropriately skilled personnel.

Recommendation 9: That the government of Ontario allocate funding on a priority basis, to increase the supply of highly skilled personnel in this industry. That mechanisms be developed to create a stronger interface among industry, labor and government to evaluate future requirements and create appropriate educational and training programs. Finally, that actions be taken quickly, given the long lead time associated with training and education in this industry.

Rationale: Ontario is experiencing shortages of electrical and electronic engineers, experienced

computer specialists and engineering technicians and technologists. Software skills are a special problem. These shortages will continue over the next five years. This lack of skills may, therefore, be a major inhibitor to the development of industry and to the diffusion of microelectronics.

Opportunities for the Disabled

Objective: To maximize the opportunities that microelectronics-based products and services can provide for the disabled in terms of employment, education and technical aids.

Recommendation 10: That the Ontario government support the development and use of microelectronic products that help disabled people overcome their handicaps.

Rationale: One of the challenges for society and for government has been to assist disabled people to help themselves. Applications of microelectronics have already been seen to be beneficial in counteracting some physical disabilities. The potential is clearly evident to counteract many other kinds of disabilities but it will require government action to support and guide the necessary research and development work.

Education and Awareness

Objective: To improve people's awareness and understanding of microelectronics, assist in the adjustment to the technology and narrow the gap between the information-rich and information-poor.

Recommendation 11: That the Ontario government support the delivery of public-awareness and education programs that emphasize the potential of microelectronics and the opportunities and benefits created for individuals by microelectronics.

Rationale: Microelectronics applications will multiply rapidly and many of these applications will be highly visible to the public (e.g. supermarket check-out registers). Recent public-opinion polls indicate only 9 percent of the population of Ontario say they "know a lot about microelectronics" and many people express concerns about the potentially harmful effects of microelectronics on personal privacy and employment.

Public-awareness and education programs will increase understanding of the applications of microelectronics, emphasize the positive effects and new opportunities and improve computer literacy.

Recommendation 12: That the Ministry of Education ensure that all students learn about computers and the role they play in daily life. This

understanding should arise from classroom courses and from the use of computers and computerized products in the classroom and within the administration of the educational system.

That the Ministry of Education and the Ministry of Colleges and Universities explore the application of microelectronics for educational purposes and commission the development and production of hardware and software that can be used for instructional purposes. In addition, that the ministry co-operate in developing the systems needed to produce and distribute these products, help teachers acquire the skills they need to use them and, to the greatest extent possible, make use of products that are developed and produced in Canada.

Rationale: The educational system has a key role to play in developing an understanding of technology and computer literacy in society. Both are essential if the benefits of the technology are to be fully realized in Canada. In addition, the educational market offers substantial industrial opportunities for Canadian firms.

Recommendation 13: That the government of Ontario support public access to microelectronics-based information services through libraries and information centres.

Rationale: Demand for information services in Ontario is heaviest from groups that are well-educated, well-informed, and have high incomes. As more information becomes available and easily accessible only in computerized systems, those without home equipment or the knowledge and skill to use publicly provided information services will be at a disadvantage. Control of information is one of the top three public concerns in Ontario regarding the impact of microelectronics.

The above recommendation will make the transition of information to our society less traumatic and socially costly. It also offers the Canadian manufacturer of equipment and services a home market that sees the advantages of such products and lays the base for a more competitive position in international markets.

Further Analysis

As a final recommendation, the Task Force suggests that the Ontario government continue its initiative by establishing a further Task Force to complete the analysis of the impact of micro-electronic products in the workplace, in education and in the home.

Appendix

Background Papers to the Task Force Report on Microelectronics

Ministry of Education, Ministry of Colleges and Universities

- (i) Background Material for Task Force on Microelectronics. *N/A*

Ministry of Industry and Tourism

- (i) Microelectronics—The Core Technology *N/A*
- (ii) Software—Intelligence Conferred *N/A*
- (iii) The Diffusion and Impact of Microelectronic Technology in Canada *N/A*
- (iv) Studies on Selected Electronic Markets *N/A*

Ministry of Labour

- (i) Labor Displacement Implications of Micro-electronic Technology in Automotive Assembly Plants: A Case Study *N/A*
- (ii) Microelectronics and Employment in Public Administration: A Case Study *CAD 0N6 53 - 82 524*
- (iii) Professional and Technical Manpower Requirements and Suppliers of the Microelectronics Industry in Ontario: 1981–1985 (prepared by the Ontario Manpower Commission)
MICRO 606 82-3709

Ministry of Transportation and Communications

- (i) Societal Impacts of Microelectronics
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